Potential Management Questions for the FKNMS

Biodiversity

* *CR Question: What is the status of biodiversity and how is it changing?*

Metrics: size and age class measures of reef fish

* What species should be tracked to indicate when conditions are normal and abnormal with respect to influences on ecosystem integrity?

Key species/focal species (keystone, foundation, indicator, etc.)

* *CR Question: What is the status and trend of key species and how is it changing?*
* What is the status and trend of **stony coral** and how is it changing?

Metric: coral cover, algae cover, disease, growth rates (accretionary and lateral)

* What is the status and trend of **black sea urchin** (*Diadema antillarum*) and how is it changing?

Metric: abundance

* What is the status and trend of **Caribbean spiny lobster** and how is it changing?   
  Metric: abundance and distribution
* *CR Question: What is the status of other focal species and how is it changing? (e.g. manatees, sea turtles, grunts, etc.)*
* What is the status and trend of **grouper-snapper complex** (white grunt, blue stripped grunt, mutton snapper, gray snapper, yellowtail snapper, hogfish, red grouper, black grouper, Graysby) and how is it changing?   
  Metric: density
* What is the status and trend of **sea turtles** and how is it changing?
* What is the status and trend of **herbivorous reef fish** and how is it changing?
* What is the status and trend of **ecologically important species** (e.g. top predators and their prey, herbivorous species) and how is it changing?
* What is the normal range of variation of keystone and foundation species on seasonal to decadal time scales?
* Is the status of keystone species for sanctuary ecosystems within the normal range of variation, given the current condition of controlling factors?
* Is the status of foundation species for sanctuary ecosystems within the normal range of variation, given the current condition of controlling factors?
* What can be done to reduce the prevalence of diseases affecting  “key” species (e.g., sea turtles, corals, marine mammals)?
* What impact will changing sea levels have on animal health and protection in the Florida Keys?
* What impact will changing ocean chemistry have on animal health and protection in the Florida Keys?
* What impact will increased sea surface temperatures have on animal health and protection in the Florida Keys?
* How will climate change effect seabird breeding success (e.g., change foraging or rearing behavior of adults)? Question:
* Are critical multi-species relationships intact?
* What is the status of cleaning stations and how are they changing?  
  Metrics: Counts of multi-species forage events; Counts of cleaning stations
* What can be done to reduce the prevalence of diseases affecting "key" species (e.g., sea turtles, corals, marine mammals)?

Invasive species

* *CR Question: What is the status and trend of invasive species and how is it changing?*

Example: What is the status and trend of **lionfish** and how is it changing?

* How should resource managers prioritize control efforts on particular invasive species populations in the Florida Keys?
* What are the most important considerations of species range expansion (invasions) due to climate change, and how will they effect FKNMS management?
* How is the lionfish population changing over time in FKNMS?
* What locations (depths, habitat types, etc.) are colonized or recolonized most quickly?
* How effective is removal in controlling invasive lionfish and how are native populations responding?
* How much effort is required to control lionfish in FKNMS, and is this effort sustainable?
* Assess impact to reefs caused by divers hunting lionfish.
* Assess economic impacts of the lionfish invasion.

Climate Change and Ocean Acidification

* What characteristics of a specific geographic area confer resistance or resilience to bleaching, disease, and effects of climate change?
* What characteristics of each coral species confer resistance or resilience to bleaching, disease, and effects of climate change?
* How far in advance can bleaching events be predicted using currently available tools?
* What is the predictability of bleaching and disease events in terms of duration and geographic scope?
* How do bleaching and disease conditions affect other components of the ecosystem (e.g., fish, reef invertebrates, sponge pumping rates, etc.)?
* How do increased concentrations of carbon dioxide (i.e., ocean acidification) affect reef accretion, coral larvae formation, metamorphosis, growth and survival, resistance or resilience to disease, bleaching, and other stressors?
* How do increased concentrations of carbon dioxide (i.e., ocean acidification) affect physiologic development in fish? Does this in turn affect their foraging or defensive behaviors?
* How do increased concentrations of carbon dioxide (i.e., ocean acidification) affect sponge spicule development? Invertebrate exoskeletal development?
* What impact will changing sea levels have on animal health and protection in the Florida Keys?
* What impact will changing ocean chemistry have on animal health and protection in the Florida Keys?
* What impact will increased sea surface temperatures have on animal health and protection in the Florida Keys?
* How will climate change effect seabird breeding success (e.g., change foraging or rearing behavior of adults)?

Fishing Impacts

* How effective are SPAs and other FKNMS zones in the preservation of finfish populations?
* What are the effects of new artificial reefs, including the USS Hoyt Vandenberg, on local fish communities, and how do those effects cascade into the surrounding diversity of fish or habitat?

Water Quality

* What are the nutrient loadings from Florida Bay and the Gulf of Mexico into waters surrounding the Florida Keys?
* What are the impacts of episodic events, such as rainfalls, major storms, and upwellings, on water quality parameters upstream and within the Sanctuary?
* How does nutrient load flux in the water column during upwelling events, particularly at the reef tract?
* What is the organic and nutrient loading contribution of decomposing seagrass and algae wrack that accumulates along shorelines and in canals and other confined water bodies, in near shore waters?
* Where are injection wells and arrays of wells not functioning properly and acting as sources of pollution to local ground water?
* What are the geochemical changes in wastewater injected into disposal wells as it passes through limestone, and are these changes detrimental to local water quality?
* What are the effects of pest control sprays (e.g., mosquito control) on non-target organisms?
* Can a nutrient loading model be developed for the FKNMS ecosystem using existing research and data?
* Is the abundance and/or distribution of biogenic habitat changing?

Marine Debris

* What are the accumulation rates of marine debris within the sanctuary?
* Are certain areas of the sanctuary more or less susceptible to marine debris accumulation and/or impacts?
* Are there critical habitat areas that should be prioritized for marine debris removal efforts?

References:

* FKNMS, Condition Report
* FKNMS, Sentinel Site, Science Needs and Questions: <http://sanctuaries.noaa.gov/science/sentinel-site-program/florida-keys/fishing-impacts.html>
* Gittings, excel sheet with potential BON questions based on CR questions
* Hepner, more specific questions reflecting the CR questions